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EDX-analysis for thin films thicknesses determination

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Recent progress in thin film semiconductor technology requires using of express methods for film analysis, especially for measuring film thickness. From this point of view, energy-dispersive x-ray (EDX) analysis is rather promising. The technique is often based on conventional scanning electron microscope (SEM), which is quick and accessible. However, reliability and accuracy of film thickness measurement from EDX results can be insufficiently high.

The accuracy of the technique can be improved by performing EDX scanning at multiple acceleration voltages (AV). Primary electrons at 5-25 kV penetrate sample by 0.5-2 micrometers respectively, resulting in different EDX spectra. By comparing the spectra, accurate thickness measurements can be carried out. The spectra is usually compared and calculated with special software products like STRATAGEM.

This work is focused on measuring thickness of silicon films on sapphire substrates (SOS). SOS films are fine model samples to calibrate the technique due to their simplicity of preparation and analysis. The films were deposited via chemical vapor deposition (CVD) with thickness ranging from 80 to 800 nm. Microscopy studies were performed at LEO Supra 50 VP SEM (acceleration voltage 5-25 kV, magnification 5000 – 50000). EDX studies were performed at SEM Zeiss EVO 50 with EDX analyzer e2v Sirius SD IXRF. Calculation of film thickness using EDX spectra were performed by STRATAGEM software.

SOS film cross-section SEM images were used for thickness measurements. The same samples were analyzed with EDX technique to deduce correct Si film mass density value used by STRATAGEM software. The density was estimated as 1.9 ± 0.2 g/cm3. The density of Si- thin films is as different as Si-reference value because the real structure of thin films content defects like dislocations, strain etc.

The film thicknesses of another SOS samples were calculated using the calibrated software. The absolute error of thickness measurement is less than 50 nm (for films with thickness ranging from 200 to 1000 nm) while the error of a single acceleration voltage measurement is more than 100 nm.

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